



THE ROLE OF DIGITAL INCLUSION IN PROMOTING ACCESS TO EDUCATION AND RURAL DEVELOPMENT IN SOUTH AFRICA: NORTH WEST PROVINCE CASE STUDY

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Article Information:

Article Type:
Research Article

Manuscript Received:
15 February 2026

Final Revision Received:
19 May 2026

Published Online:
31 August 2026

Keywords:
Digital inclusion, Rural Education, ICT4D, E-Governance, North West Province, South Africa, Educational Equity, Digital Divide.

The availability of quality education remains a continual challenge in rural areas worldwide, particularly in developing countries such as South Africa. Despite numerous efforts to encourage equitable education, digital inequality continues to obstruct progress in rural communities, where limited infrastructure, low computer literacy, and historical disparities contribute to the widening digital divide. This study considers the function of digital inclusion in enhancing educational access and supporting rural development in South Africa. Adopting a qualitative research design and purposive sampling, the study examined 26 teachers from selected rural schools in the North West province and 53 students to understand how digital tools and initiatives influence educational outcomes and add to broader development goals. The findings show a complicated landscape characterised by paradoxes: 53% of teachers received formal training, yet usage frequency shows no correlation with training status; 80% of students report school access to devices, while teachers indicate severe infrastructure inadequacies; and 30% of students lack home internet access, creating a significant homework gap. The study pinpoints critical barriers, including unreliable electricity supply, insufficient connectivity, and device scarcity, and offers important insights for policymakers, educators, and development stakeholders on how to leverage digital inclusion as a strategic instrument for improving rural education.

Cite this article: Mooki Lobelo (2026). The Role of Digital Inclusion in Promoting Access to Education and Rural Development in South Africa: North West Province Case Study. The Journal of Sustainable Development, Law and Policy. Vol. 18:2. 331-352. DOI: 10.4314/jsdlp.v18i2.13.



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Publisher: Institute for Oil, Energy, Environment and Sustainable Development (OGEES Institute), Afe Babalola University, Ado Ekiti, Nigeria.

1. INTRODUCTION

Digital technologies have become fundamental to modern education and socio-economic development. However, disparities in digital access between urban and rural areas have exacerbated existing inequalities, particularly in education. In South Africa, rural communities, shaped by historical disadvantage and systemic underinvestment, often lack the infrastructure and support needed to benefit from digital advances. This digital inclusion gap contributes to poor educational outcomes, unemployment, and broader rural underdevelopment. While global literature highlights the potential of digital inclusion to transform rural education, context-specific research in South Africa, particularly in the North West province, remains limited. This study aims to bridge this research gap and provide actionable insights. Lobelo and Tshidzumba assert that the conception of development, particularly rural development, conveys government responsibilities, more precisely, local government. Hence, the South African government founded the National Development Plan (NDP) Vision 2030 to improve service delivery and development for its constituencies.

As Carrim and Bekker¹ point out, the COVID-19 pandemic has brought to the surface the stark inequalities across the world. Such inequalities include the lack of basic facilities in schools and in communities, and several levels of interlocking inequalities have also revealed the vast disparities that exist within and across schools, where mainly private schools who are better resourced have access to digital technologies and were able to move to online teaching and learning, while other, mainly public schools, are under resourced and do not have access to or even prior exposure to digital technologies. As Rapp and Corral-Granados² note, the meaning of the term 'inclusion' is often taken for granted and seldom defined. Empirical research on inclusive education is often normative, as it is based on terms such as 'justice' and 'democracy', which are challenging to translate into real practice because their meanings depend

¹N Carrim and T Bekker, 'Placing Inclusive Education in Conversation with Digital Education' (2022) 34(2) South African Computer Journal 18

²AC Rapp and A Corral-Granados, 'Understanding Inclusive Education' (2021) 28(4) International Journal of Inclusive Education 423.

on subjective evaluations tied to the time and place where inclusion is supposed to happen. Inclusive education, therefore, is challenging to explore in research and to achieve in educational situations.

In an era characterised by globalisation and rapid technological change, the role of education as a tool for development has evolved significantly. Rural communities, once marginalised in national development agendas, are now emerging as pivotal sites for innovation, largely due to the growing penetration of digital technologies. In South Africa, particularly in the North West Province, education and governance structures are undergoing significant transformation through the integration of Information and Communication Technologies (ICTs), participatory communication, and multisectoral development models. These frameworks not only promote good governance and improved service delivery but are also instrumental in closing the rural-urban educational divide. Lobelo and Tshidzumba assert that the advent of Information and Communication Technologies (ICTs) has brought about rapid transformation from analogue to digital communication. The digital divide poses a greater threat to community service and rural development, with the government failing to provide effective and efficient communication strategies for delivering services to rural communities.

Digital technologies such as smartphones, mobile internet, artificial intelligence (AI), and cloud platforms have redefined how public services are delivered. Hund and others³ Note that digitalisation catalyses new modes of innovation, allowing for novel combinations of digital and physical components. In rural education, this manifests as mobile learning (m-learning) platforms, e-governance portals for school registration, and data-driven decision-making processes within local education authorities. Lobelo⁴ underscores the transformative potential of ICTs in enabling access to information and in strengthening community agency. In the North West Province, smartphones have become crucial tools for

³A Hund, HT Wagner, D Beimborn and T Weitzel, 'Digital Innovation: Review and Novel Perspective' (2021) 30(4) *Journal of Strategic Information Systems* 101695.

⁴M Lobelo, 'An Analysis of North West Provincial Government's Communication System towards Rural Development: A Multisector Approach' (PhD thesis, North-West University 2020).

education, allowing learners to access digital libraries, connect with educators, and participate in m-government processes such as reporting school service issues.

Despite evident progress, several challenges hinder the full realisation of ICT-driven educational transformation. A significant hurdle is the lack of collaboration among departments and insufficient understanding of communication as a strategic resource. Additionally, budget constraints, poor digital infrastructure, and the absence of a unified ICT policy across education and municipal departments further exacerbate disparities.⁵ While global literature highlights the potential of digital inclusion to transform rural education, context-specific research in South Africa, particularly in the North West Province, remains limited. This study aims to bridge this research gap by investigating how digital inclusion operates within the specific constraints and opportunities of schools in the rural North West Province, providing actionable insights for policy and practice.

This study aims to assess the level of digital access and literacy among students and teachers in rural schools; examine the impact of digital inclusion on teaching and learning outcomes; explore the relationship between digital access and rural social development; and identify barriers and opportunities for promoting digital inclusion in rural North West schools.

This study is organised into six sections. This section introduces the study by outlining the research problem, defining key concepts, and establishing the significance of digital access in education and rural development. Section 2 presents the literature review, examining the constitutional, legislative, and policy frameworks that guide digitisation within the education sector. It also reviews previous studies that highlight the benefits of digitalisation and provide evidence of its impact on educational outcomes and development. Section 3 sets out the study's theoretical framework, focusing on Information and Communication Technologies for Development (ICT4D) and e-governance theories, and their relevance to digital access in education. Section 4 outlines the research methodology

⁵ *ibid.*

and design, detailing the procedures for data collection and analysis. Section 5 presents and analyses the empirical findings, linking the data to the study's objectives and the broader literature. Finally, Section 6 summarises the conclusions and recommendations drawn from the findings, offering insights for policy, practice, and future research.

2. LITERATURE REVIEW

This literature review examines key perspectives shaping contemporary educational transformation in the digital age. With increasing emphasis on equitable access to technology, digital inclusion in education is a critical foundation for ensuring that all learners can participate meaningfully in digital learning environments. The review further explores multisector approaches to educational upliftment, highlighting collaborative efforts among governments, private organisations, and communities to strengthen educational systems and bridge structural inequalities. Finally, attention is given to teacher and learner ICT efficacy and pedagogy, focusing on the competencies, confidence, and instructional practices required to integrate digital tools effectively into teaching and learning. Together, these themes provide a comprehensive understanding of the opportunities and challenges associated with advancing inclusive, technology-enabled education. Lobelo emphasised that South Africa remains characterised by weak institutions, political dominance, and a lack of transparency and accountability, which consequently lead to poverty, inequality, and unemployment among the populace.

2.1 Digital Inclusion in Education

In the realm of education, digital inclusion translates into policies promoting free WiFi zones in schools, e-learning platforms in local languages, and mobile apps for student progress tracking. Mintz and others⁶ note that digital inclusion in education could be considered to draw on several policy frameworks: human rights law (for example, the UN Declaration of Human Rights 1948, the Salamanca Declaration 1994,

⁶ J Mintz, C Connolly, E O'Brien, L Daniela and TJ Ó Ceallaigh, 'Inclusive Digital Education: Contexts, Practices and Perspectives' (2024) 41(2) *Computers in the Schools* 115.

and the UN Convention on the Rights of Persons with Disabilities 2006); educational policy and legislation which varies depending on jurisdiction; and legislation related to digital technology services and use, information compliance and data protection.

National education policy and legislation underscore digital inclusion as a driver of quality learning. Key frameworks include the South African Schools Act 84, the White Paper on e-Education, and subsequent Department of Basic Education (DBE) ICT-in-Education strategies, which emphasise integrating digital technologies into teaching and learning to advance equity, improve pedagogical practice, and address historical disparities in educational access. Initiatives such as the National Development Plan 2030 further position ICT as a catalyst for socio-economic transformation and skills development. In South Africa, human rights law is embedded in section 29 of the Constitution, which guarantees the right to basic education and equal access to learning opportunities. Despite evident policy progress, several challenges hinder the full realisation of ICT-driven educational transformation. Mintz and others⁷ emphasise that the challenge for digital inclusion is to consider how technology can help address barriers to entry, participation, engagement and recognition of learning for diverse and marginalised groups. Digital technologies may well have the capacity to support education in becoming inclusive in relation to these challenges, but a critical perspective on their use and the policy framework for use will be needed if the promise is to translate into actuality. Ramirez-Montoya and others⁸ Note that inclusive digital education is a field where teachers must be aware of their responsibilities and the need for continuous preparation, not only in the use of technology but also in attending to students' diverse ways of accessing content. The challenges of inclusive digital education with universal learning designs require special attention in a world where technological advances proceed at a breakneck pace.

⁷ Mintz and others (n 9).

⁸ MS Ramirez-Montoya, JC Weber, G Cox and GC Tenorio-Sepulveda, 'Inclusive Digital Education on Open Platforms' (2024) *Computers in the Schools* (advance online publication) 1.

Peruzzo and Allan⁹ present five concepts describing convivial technologies for inclusion: accessibility, affectivity, presentness, interdependency, and relatedness. These concepts capture the convivial use of technologies for inclusion within local education assemblages that are increasingly shaped globally. Rapp and Corral-Granados¹⁰ explore the understanding of inclusive education through the lens of social system theory developed by Niklas Luhmann, as well as the theory of institutionalism. They highlight how subsystems include and exclude, identifying the criteria that govern a system's access and rejection. Their study concludes that several institutionalisation processes take place simultaneously within schools, and that aspects such as test culture, homework, and parental involvement often exclude students from lower socio-economic backgrounds.

Carrim and Bekker¹¹ argue that the expansion of digital education must be grounded in principles of inclusivity to avoid reinforcing existing inequalities, noting that lessons from inclusive education offer critical guidance for reimagining digitally mediated learning. They emphasise that both inclusive and digital education require a fundamental redefinition of educational values and assumptions held by educators, learners, and society. Complementing this view, Duarte and others¹² demonstrate that effective digital inclusion depends on sustained teacher training, while underscoring persistent challenges in infrastructure and institutional support.

⁹ F Peruzzo and J Allan, 'Rethinking Inclusive (Digital) Education: Lessons from the Pandemic' (2022) 49(2) *Learning, Media and Technology* 244.

¹⁰ Rapp and Corral-Granados (n 3).

¹¹ Carrim and Bekker (n 2).

¹² SJ Duarte, VLK Brugnera, MB Silva, MS Pedro and D Da Silva, 'The Importance of Digital Inclusion in Modern Education' (2024) *Revista Arace*.

2.2 Multisectoral Approaches for Educational Upliftment

A multisectoral approach involves collaboration among government departments, the private sector, and civil society to achieve development objectives.

Salunke and Lal note that a multisectoral approach entails deliberate collaboration among various stakeholder groups and sectors to jointly achieve policy outcomes. By engaging multiple sectors, partners can leverage knowledge, expertise, reach, and resources, drawing on their combined strengths towards shared goals. Lobelo proposes that development communication, especially participatory models, is foundational to sustainable rural development. When applied to education, such models ensure that community voices are integrated into curriculum design, school infrastructure planning, and digital literacy initiatives. Lobelo, Siphuma and Segalwe¹³ demonstrate that ICT tools, such as mobile communication platforms, social media, and internet-based systems, enhance community participation by enabling real-time engagement and expanding access to municipal information. However, rural communities continue to experience challenges such as the digital divide, digital illiteracy, and poor infrastructure, which hinder full democratic participation. A study by Djafri and Al-Amin¹⁴ explores ways to address educational disparities through a multisectoral approach, emphasising the importance of policies that not only focus on infrastructure and curriculum but also provide social and financial support for disadvantaged groups. They emphasised that sustainable and data-driven programme planning is needed to identify the groups most in need of intervention. Djafri and Al-Amin¹⁵ Also, examine the impact of multisectoral synergy on improving educational quality, showing that intersectoral synergies contribute to improving infrastructure, enhancing

¹³ M Lobelo, M Siphuma and TDP Segalwe, 'The Role of Information Communication Technology in Improving Community Participation in Municipal Processes in Rural Areas' (2025) 16(1) *Journal of Sustainable Development, Law and Policy* 209.

¹⁴ N Djafri and Al-Amin, 'Improving the Quality of Multisectoral Education through Inter-Sectoral Synergy: A Literature Review' (2025) 5(1) *Indonesian Journal of Education* 86.

¹⁵ *ibid.*

teaching staff quality, and introducing more interactive and contextualised learning methods.

2.3 ICT Efficacy and Pedagogy

ICT efficacy refers to the confidence, skills, and ability of teachers and learners to effectively use digital tools for teaching, learning, communication, and problem-solving. Mlambo, Rambe and Schlebusch¹⁶ Note that the proliferation of ICT in South African basic education has not been associated with effective pedagogical uses of ICT in classrooms. While there is differential deployment of ICT as cognitive tools of instruction, the effects of educators' ICT self-efficacy on their pedagogical use of technologies are yet to be fully grasped.

Andyani, Setyosari, Wiyono and Djatmika¹⁷ found that technological pedagogical content knowledge influences ICT use in pedagogy, and that organisational innovative climate affects both teachers' self-efficacy and ICT use. This highlights the importance of institutional culture in supporting digital integration. Mlambo, Rambe and Schlebusch¹⁸ found that ICT self-efficacy had a positive and significant, but moderate, effect on the traditional pedagogical use of ICT, and a positive and significant, strong relationship with the constructivist pedagogical use of ICT. The study recommends initial educator training emphasising extended hands-on engagement with ICTs in classroom environments. Kundu, Bej and Dey¹⁹ found that participant teachers' overall ICT self-efficacy was moderately low, and their perception of ICT infrastructure was also far below the expected level. The investigation found a moderately high positive correlation between teachers' ICT self-efficacy and their overall

¹⁶ S Mlambo, P Rambe and L Schlebusch, 'Effects of Educators' ICT Self-Efficacy on Pedagogical Use of ICTs' (2020) 6(4) *Heliyon* e03730.

¹⁷ H Andyani, P Setyosari, BB Wiyono and ET Djatmika, 'Does Technological Pedagogical Content Knowledge Impact on the Use of ICT in Pedagogy?' (2020) 15(3) *International Journal of Emerging Technologies in Learning* 126.

¹⁸ Mlambo, Rambe and Schlebusch (n 26).

¹⁹ A Kundu, T Bej and KN Dey, 'An Empirical Study on the Correlation between Teacher Efficacy and ICT Infrastructure' (2020) 37(4) *International Journal of Information and Learning Technology* 213.

perception of ICT infrastructure, suggesting that infrastructure quality directly influences teacher confidence and usage.

3. THEORETICAL FRAMEWORK: ICT4D AND E-GOVERNANCE IN EDUCATION

The theoretical framework of ICT4D (Information and Communication Technologies for Development) underscores the pivotal role of digital tools in promoting socio-economic transformation.²⁰ Debbarma²¹ emphasises that e-governance in education offers multiple advantages, reshaping the educational landscape for the betterment of the future through enhanced efficiency, transparency, and accessibility. Digital classrooms and online learning platforms can be used to deliver high-quality educational content to students in distant regions, extending inclusivity and equity in education, and bridging the urban-rural educational divide.

Khan, Ullah and Nobanee²² note that ICT adoption and innovation relate to the technology spillover effect theory, where technological advances in one area or region may spread to benefit other sectors or locations. Ooko and Cheptegei²³ Outline that ICT4D refers to the application of ICT to socio-economic development, enhancing the effectiveness of service delivery and governance, especially in developing countries. They outline the evolution from ICT4D 1.0 (focused on providing basic ICT infrastructure) to ICT4D 2.0 (emphasising mobile technologies) to

²⁰ C Avgerou, 'Theoretical Framing of ICT4D Research' in J Choudrie, MS Islam, F Wahid, JM Bass and JE Priyatma (eds), *Information and Communication Technologies for Development: 14th IFIP WG 9.4 International Conference, ICT4D 2017* (Springer 2017) 10; R Heeks, 'ICT4D 3.0: The Components of an Emerging "Digital-for-Development" Paradigm' (2020) 86(3) *Electronic Journal of Information Systems in Developing Countries* e12124.

²¹ A Debbarma, 'E-Governance in Education Management: Utilizing ICT for Efficiency and Transparency in Tripura' (2023) 7(11) *International Journal of Academic Multidisciplinary Research* 283.

²² S Khan, S Ullah and H Nobanee, 'ICT Diffusion, E-Governance and Sustainability in the Digital Era' (2024) 8 *Sustainable Futures* 100272.

²³ SO Ooko and L Cheptegei, 'Information and Communication Technology for Development (ICT4D) and Its Areas of Application' (2025) 6(2) *MUST Journal of Research and Development* 11.

ICT4D 3.0 (aligned with sustainable development goals, focusing on transformative, inclusive, and sustainable approaches).

4. METHODOLOGY

This study adopted a qualitative research design employing purposive sampling to examine digital inclusion in rural schools within South Africa's North West Province. The choice of qualitative methodology was appropriate for exploring the complex, contextual, and experiential dimensions of digital inclusion in education, particularly the lived realities of teachers and students navigating infrastructure limitations, pedagogical challenges, and socio-economic barriers.

Table 1: Study Design and Participant Characteristics

Category	Details
Research Design	Qualitative, exploratory
Sampling Strategy	Purposive sampling
Study Site	Selected rural schools, North West Province, South Africa
Data Collection Period	June – December 2025
Total Participants	N = 79

4.1 Research Design and Sampling

This study adopted a qualitative exploratory research design to examine digital inclusion within rural educational contexts. A purposive sampling strategy was employed to select participants with direct experience of

digital teaching and learning in rural schools. The research was conducted in selected rural schools in the North West Province, South Africa, from June to December 2025. A total of 79 participants were drawn from multiple rural villages and schools and were divided into two main groups. The first group included teachers and school administrators ($n = 26$). Participants ranged in age from 30 to over 60 years, with approximately 69% aged 50 years and above. Teaching experience ranged from 10 to over 30 years, with an average of 20 years. The group represented a range of professional roles, including classroom teachers, department heads, principals, and course instructors, and was drawn from multiple primary schools across rural villages in the North West Province. The second group consisted of students ($n = 53$) enrolled in Grades 7-10. Among these learners, 80% reported having access to digital devices at school, while 70% indicated access to the internet at home.

4.2 Data Collection

Semi-structured questionnaires for teachers covered demographic information, digital access and usage patterns, formal training received, confidence levels, perceived benefits and barriers, and beliefs about digital inclusion's role in rural development. Structured questionnaires for students focused on access to digital devices at school and home, internet connectivity, usage frequency, digital confidence, and challenges faced.

Questionnaires were administered in person at selected rural schools. Teachers completed comprehensive questionnaires covering all research objectives. Students completed shorter questionnaires appropriate to their age and understanding. Informed consent was obtained from all participants (and parental consent for minors). Confidentiality and anonymity were assured through participant coding (T1–T26 for teachers, S1–S53 for students).

Table 2: Data Collection Instruments

Instrument	Target Group	Focus Areas
Semi-structured questionnaire	Teachers (n = 26)	Demographics; digital access/usage patterns; formal training; confidence levels; perceived benefits/barriers; beliefs on digital inclusion’s role in rural development
Structured questionnaire	Students (n = 53)	Device access (school/home); internet connectivity; usage frequency; digital confidence; challenges faced

4.3 Data Analysis

Data were analysed using Braun and Clarke's²⁴ Six-phase thematic analysis approach.

Phase 1: Familiarisation. Multiple readings of consolidated questionnaire responses to gain a comprehensive understanding of the data. Initial noting of patterns, contradictions, and surprising findings, such as the confidence-usage paradox and the device storage phenomenon. **Phase 2: Generating Initial Codes.** Systematic coding of responses related to key dimensions: digital access (devices, connectivity, infrastructure), usage patterns (frequency, contexts, barriers), confidence and efficacy (self-assessment, training background), perceived impacts (on learning, engagement, rural development), and barriers (technical, institutional, socio-economic). **Phase 3: Searching for Themes.** Codes were clustered into preliminary themes aligned with research objectives. These included: infrastructure crisis (electricity, connectivity, device adequacy), training paradox (formal training vs. actual usage), multilevel digital divide (access,

²⁴V Braun and V Clarke, 'Using Thematic Analysis in Psychology' (2006) 3(2) Qualitative Research in Psychology 77.

skills, usage, outcomes), homework gap (home internet disparities), village-level stratification (intra-rural inequalities), and rural development potential (recognized but unrealised).

Phase 4: Reviewing. Themes were reviewed against the research questions and refined for internal coherence and distinctiveness. Cross-stakeholder perspectives (teachers vs. students) were examined to validate or problematize emerging themes. **Phase 5: Defining and Naming Themes.** Research refined the essence of each theme and described how it relates to the research objectives regarding Training–Usage Disconnect, Infrastructure Trilemma, Intra-Rural Inequality and Institutional Barriers. Effective naming was kept concise and reflective. Supporting quotations and detailed descriptions were developed to enhance clarity. **Phase 6: Producing the Report.** Themes were interpreted within the South African rural education context, connected to the ICT4D and inclusive education literature, and supported by evidence from participant responses.

4.4 Data Triangulation and Validation

Multi-stakeholder Triangulation: Teacher perspectives were systematically compared with student experiences to identify convergences (e.g., infrastructure barriers) and divergences (e.g., perception of “adequate access”). This triangulation revealed important gaps between institutional intentions and student realities.

Geographic Triangulation: Data from multiple villages within North West Province enabled the identification of intra-rural variations, particularly the stark differences in connectivity between high-access villages (100% home internet) and low-access villages (45% home internet). **Methodological Triangulation:** Quantitative frequency distributions (usage rates, training percentages, access levels) were integrated with qualitative interpretations of open-ended responses about benefits, barriers, and development potential, providing both breadth and depth of understanding.

Table 3: Ethical Considerations

Aspect	Procedure
Administration	In-person, at selected rural schools
Consent	Informed consent (all participants); parental consent for minors
Confidentiality	Participant coding system (T1–T26 teachers; S1–S53 students)
Anonymity	Ensured via coding, no identifying information used

4.5 Limitations

The study acknowledges several limitations: the relatively small sample size (79 participants) limits statistical generalizability; cross-sectional design captures only a snapshot rather than longitudinal change; self-reported data may involve overestimation or misunderstanding of concepts like “access” and “confidence”; incomplete demographic data for some teacher participants limited certain comparative analyses; and the study focused exclusively on North West Province, potentially limiting applicability to other South African provinces with different socio-economic and infrastructure contexts. Despite these limitations, the study's qualitative depth, multi-stakeholder approach, and village-level granularity provide valuable contextual insights into the realities of digital inclusion in rural South African education, insights that can inform more targeted and effective policy interventions.

5. FINDINGS AND DISCUSSION

The findings reveal a paradoxical landscape of digital inclusion in rural schools in the North West Province. Although policy frameworks and limited infrastructure are in place, meaningful integration of digital technologies into teaching and learning remains constrained by interconnected systemic barriers. Access has not translated into sustained use or improved educational outcomes.

5.1 The Training–Usage Disconnect

Despite 53% of teachers reporting formal ICT training, no clear relationship emerged between training and classroom use of digital technologies. Only 30% of trained teachers reported frequent use, while 40% used digital tools rarely or never. Conversely, some of the most active adopters had received no formal training, indicating that current professional development models are ineffective. This finding extends Duarte and others²⁵ by demonstrating that training alone is insufficient when it is short-term, technically focused, decontextualised, and unsupported by infrastructure or follow-up mentoring. Consistent with Mlambo, Rambe and Schlebusch,²⁶ effective digital integration depends less on exposure to tools than on pedagogical self-efficacy, contextual relevance, and institutional support. The success of untrained but motivated teachers highlights the importance of intrinsic motivation, peer learning, and functional infrastructure. Policy implication: Professional development must shift from generic workshops to context-specific, pedagogically embedded, and mentored models, implemented alongside infrastructure support.

5.2 The Infrastructure Trilemma

Digital inclusion efforts are undermined by an interdependent infrastructure trilemma: unreliable electricity, poor internet connectivity, and inadequate or non-functional devices. Teachers consistently identified electricity outages and weak or absent connectivity as primary barriers, rendering digital lesson planning and implementation unreliable. These

²⁵Duarte and others (n 19).

²⁶Mlambo, Rambe and Schlebusch (n 26).

findings confirm that rural schools remain trapped at an ICT4D 1.0 stage, where foundational infrastructure deficits prevent progression to more transformative digital pedagogies.²⁷ The persistent connectivity gap also highlights a significant disconnect in policy implementation, despite national broadband ambitions. Device availability alone proved insufficient. Several schools reported having no computers, while others stored available devices unused. This “storage paradox” reflects security concerns, lack of confidence, absence of connectivity, and institutional risk aversion, demonstrating that physical presence of technology does not equate to functional access.²⁸ Policy implication: Infrastructure interventions must be integrated to address electricity, connectivity, devices, security, and technical support simultaneously. Piecemeal solutions are ineffective.

5.3 The Homework Gap and Intra-Rural Inequality

While 80% of students reported having access to devices at school, only 70% had home internet access, resulting in a 30% homework gap. Students without home connectivity are systematically disadvantaged in completing digital assignments, accessing supplementary resources, and developing independent digital literacy. This gap is geographically concentrated, with some villages reporting 100% home connectivity and others as low as 45%, revealing profound intra-rural stratification. These findings challenge homogenised notions of “rural” and support Peruzzo and Allan's²⁹ argument that remoteness is infrastructural and socio-economic, not merely geographic. Teachers face ethical and pedagogical dilemmas: assigning digital homework exacerbates inequality, while avoiding it limits the development of digital skills for all learners. This tension partly explains low levels of classroom digital use. Policy implication: Digital equity strategies must extend beyond schools to community-level connectivity, including after-school access centres, offline resources, subsidised data, and targeted infrastructure investment in low-access villages.

²⁷Ooko and Cheptegei (n 33).

²⁸Kundu, Bej and Dey (n 29).

²⁹Peruzzo and Allan (n 16).

5.4 Perception Gaps and Institutional Barriers

A clear perception gap emerged between teachers and students regarding “access.” Students often reported access as occasional exposure, while teachers defined access as sufficient, reliable, and pedagogically meaningful use. Stored or demonstration-only devices represent ceremonial access, not functional inclusion.³⁰ Age and experience did not predict digital adoption. Both younger and older teachers displayed varied usage patterns, indicating that organisational culture and infrastructure conditions, rather than demographics, shape digital engagement.³¹ Teachers nonetheless expressed strong belief in digital inclusion's potential for rural development, linking it to learner performance, global relevance, and community upliftment. However, this optimism was consistently conditional, constrained by the absence of infrastructure and institutional support.

5.5 Synthesis: A Multilevel Digital Divide

Taken together, the findings reveal a multilevel digital divide operating across material access, skills and usage, and outcomes, consistent with van Dijk's³² framework but contextualised for rural South Africa. At the material level, infrastructure deficits, village-level disparities, the homework gap, and the use of stored devices prevent meaningful access. At the skills and usage level, the training–usage disconnect and perception gaps limit pedagogical integration. At the outcomes level, the widely recognised developmental potential of digital inclusion remains unrealised, producing aspiration without impact. Interventions targeting only one level consistently fail. Training without infrastructure, devices without institutional support, or connectivity without electricity results in wasted resources and frustration. Rural schools are effectively stuck between ICT4D phases, possessing partial infrastructure insufficient to enable transformative digital education.

³⁰Mintz and others (n 9).

³¹Andyani and others (n 27).

³²JAGM van Dijk, *The Deepening Divide: Inequality in the Information Society* (Sage 2005).

6. RECOMMENDATIONS

Drawing on the integrated findings, this study proposes a phased and systemic framework for advancing digital inclusion in rural South African education, encompassing immediate interventions, medium-term reforms, and long-term transformation.

6.1 Immediate Interventions

Address foundational infrastructure gaps through rapid, village-level audits that identify deficits in electricity, connectivity, and devices. Priority should be given to low-connectivity villages (45% home access), with interim solutions such as solar power systems, battery storage, mobile hotspots, and subsidised data packages deployed alongside longer-term infrastructure planning. Mitigate the homework gap by establishing school-based homework centres with internet access, extending supervised after-school hours, and providing offline digital resources for home use. Mandatory online homework should be suspended where universal home connectivity is absent, or equivalent non-digital alternatives must be provided to ensure equity.

Activate unused technology by auditing stored devices and removing barriers to use through basic security upgrades, on-site technical support, and pre-loaded offline content. Clear institutional messaging should reinforce that devices are pedagogical tools for regular use, not for preservation. Reform professional development through pilot programmes embedded in communities of practice, with a focus on pedagogical integration rather than technical skills alone. Training should be paired with functional infrastructure and sustained mentorship, and successful self-directed teachers should be studied to inform the development of scalable models.

6.2 Medium-Term Systemic Reforms

Adopt village-specific planning, replacing uniform “rural school” approaches with differentiated funding and tailored interventions that reflect local infrastructure conditions. Peer networks should link high- and low-connectivity villages, enabling resource sharing and collective problem-solving. Implement integrated infrastructure packages that

address electricity, connectivity, devices, security, and technical support in concert. Service-level agreements with providers should specify minimum bandwidth, uptime, and rapid maintenance for schools, with renewable energy systems supporting schools where grid reliability is weak.

Realign curriculum and pedagogy to distinguish digital literacy goals from subject mastery, preventing digital requirements from becoming barriers to achievement. Prioritise mobile-first and hybrid pedagogies, supported by realistic, context-sensitive teaching resources. Strengthen institutional leadership and culture through targeted training for principals and departmental leaders, the appointment of school-level digital champions, and protected time for teacher collaboration and experimentation. Enhance multisectoral coordination by establishing formal planning forums that link the education, ICT, telecommunications, energy, and local government sectors, with shared indicators to monitor infrastructure, usage, learning outcomes, and equity impacts.

6.3 Long-Term Transformative Strategies

Pursue universal home connectivity as part of educational infrastructure and a determinant of equity, supported by national targets, dedicated funding, subsidised household packages, and innovative financing mechanisms. Position schools as anchors of rural development, extending connectivity to households and local enterprises, supporting youth digital entrepreneurship, and enabling spillover benefits across agriculture, health, governance, and commerce. Transform teachers' professional identity by establishing continuous professional learning ecosystems, recognising digital pedagogical leadership, supporting teacher-led action research, and fostering national and provincial communities of practice.

Ensure sustainability by shifting from project-based interventions to long-term public funding, building local technical support capacity, planning device replacement cycles, and prioritising open-source and locally relevant content. Institutionalise monitoring and adaptive learning, tracking not only inputs but also usage, pedagogical quality, equity outcomes, and long-term impacts on education and rural development. All interventions should be guided by equity-centred design, contextual responsiveness, systemic integration, sustainability, evidence-based

adaptation, teacher agency, and a student-centred focus that prioritises learning outcomes over technological visibility.

7. CONCLUSION

This study examined digital inclusion in rural schools in South Africa's North West Province and revealed a landscape marked by paradox, stratification, and unrealised potential. Despite policy commitments and partial infrastructure provision, meaningful digital integration remains constrained by interconnected barriers spanning infrastructure, pedagogy, institutional culture, and community contexts. Empirically, the study documents a training–usage disconnect, showing that formal ICT training does not predict classroom integration; identifies a 30% homework gap that disadvantages learners without home internet access; and exposes intra-rural digital stratification, with village-level connectivity ranging from 45% to 100%. These findings challenge homogenised conceptions of “rural” education and demonstrate that access without enabling conditions produces exclusion rather than inclusion.

Theoretically, the study advances digital divide scholarship by illustrating how second-level material deficits prevent progression to skills development and outcome benefits. It extends ICT4D and inclusive education frameworks by showing that poorly designed digital inclusion initiatives risk exacerbating inequality, validating concerns raised by Carrim and Bekker.³³ The policy implications are clear: digital inclusion must move beyond device distribution toward developing an integrated ecosystem that addresses infrastructure, pedagogy, equity, and sustainability simultaneously. Village-specific interventions, reformed professional development, multisectoral coordination, and community-level connectivity are essential to translating access into meaningful educational and developmental outcomes.

Despite limitations in sample size, scope, and reliance on self-reported data, the study provides rich contextual insights and a robust foundation for future longitudinal and comparative research. Further work should

³³Carrim and Bekker (n 2).

examine pedagogical quality, spillover effects, and scalable models of success in infrastructure-constrained environments. Ultimately, digital inclusion in rural education is not primarily a technological challenge but a question of educational justice. Bridging the gap between aspiration and reality requires sustained political will, adequate resourcing, and unwavering commitment to equity. This study offers evidence-based guidance for that transformation. Whether its lessons are acted upon will shape the futures of rural learners and the communities they inhabit.